Part

E

Assessment of Watershed Disturbances and Recovery

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Purpose, Background, and Approach

Purpose

To evaluate and minimize the level and impact of land use-related disturbances in managed watersheds on the ownership, specifically as they relate to accelerated erosion and sediment yield. To estimate the current disturbance regime and to predict future levels of disturbance and recovery based on harvest planning scenarios contained in the sustained yield model.

Background

Land use activities often result in the alteration of natural physical and biological watershed attributes. The nature, severity and persistence of site disturbance resulting from a land use activity is often difficult to quantify, because it is a function of several variables, including 1) the type of land use activity, 2) where in the watershed the land use activity is conducted, 3) how well the activity is done and 4) the natural geomorphic sensitivity of the landscape. These factors make quantification difficult. For this reason, normalized, numerical disturbance coefficients can be used to track and predict relative land disturbance within watersheds. The coefficients are used as first-cut estimates of land disturbance as they relate to probable mechanisms for initiating watershed and stream channel response, specifically related to erosion and sedimentation problems. The initial selection of land disturbance coefficients relies on interdisciplinary professional judgment, and values can be refined based on known site conditions, field observations, published values, and aerial photographic analysis.

Approach

Disturbance coefficients can be developed to express the effect of land use on such variables as woody debris recruitment, hillslope stability and sediment flux, and changes in watershed hydrology. We have chosen to develop a land use disturbance index that, when combined with a watershed sensitivity index, provides a relative measure of the potential effects of land use on the geomorphology and, by inference, to the aquatic resources of each drainage basin in the ownership. Ground disturbance, for this analysis, is considered as one measure of the potential for initiating erosion and sedimentation problems in managed watersheds. In general, the greater the ground disturbance of an operation, the greater the likelihood there will be resulting erosion and sediment yield to stream channels.

Tasks

The determination of relative levels of watershed disturbance, for these purposes, is a fairly straight forward procedure involving the identification of harvest management practices (yarding techniques and silvicultural methods) and the application of multipliers to identify which areas have been disturbed to the greatest degree. Thus, yarding operations involving tractors and other ground skidding equipment are the most likely to cause the greatest unit ground disturbance (soil displacement/acre). They are also most likely to have haul roads located in the more sensitive lower slope positions. In contrast, unassisted helicopter yarding is likely to cause the least soil disturbance of modern yarding methods, and haul roads are normally located on ridge-tops where erosion and sediment problems are less likely to occur. Similarly, the greater the silvicultural intensity, the greater the chance that soil loss will occur. Thus, clear cutting is likely to produce more land disturbance, and increase the potential for soil movement and erosion, than a commercial thinning operation on the same terrain, all else being equal.

The calculation procedure outlined in this report provides a simple method to evaluate the relative landscape disturbance caused by a variety of yarding and silvicultural methods in a watershed. The numbers have no concrete meaning except in their relative relationship to one another. Taken together, they provide an relative index of the degree of management-related disturbance in a watershed, and therefore provide a useful assessment and predictive tool for land use planning.

Finally, land use disturbances and their effects tend to diminish over time. Recovery rates for vegetation are comparatively rapid in coastal watersheds and surface erosion on disturbed soils diminish quickly after the first few years. For simplicity, 10 and 20 year recovery periods were selected for analysis, depending on the availability of harvesting history data and yarding information (see discussion on site recovery, below).

How much disturbance is too much for a particular watershed depends on a variety of factors. These include watershed sensitivity (see Geomorphic Sensitivity analysis), the location of the disturbance, the type of disturbance, the duration of the disturbance and the age of the disturbance. Thus, disturbance is important not only in its magnitude, but also where it occurs, its aerial extent (relative to streams and other sensitive locations), when it occurs and over what time period. These are all factors that relate to its effect on erosion and sedimentation problems in a watershed.

Uses and Limitations

There are several methods available to reduce the potential adverse effects of land use in a geomorphically sensitive watershed. Since natural watershed sensitivity cannot be easily altered, these measures either entail 1) the use of modified land use practices to reduce the level of watershed disturbance related to land use activities from one watershed to the next, or 2) employing remedial or corrective measures to improve conditions associated with past activities.

Modified land use practices: The first type of measures are accomplished during project planning (by such techniques as avoidance of problem areas, special project layout, and special or restrictive design), during project implementation (by such things as operator and equipment selection, and special operating practices), and during the post-project phase (using special remediation and erosion prevention practices). Numerous mitigation measures and best management practices can be employed to reduce site-specific watershed impacts. These often go beyond the requirements of existing regulation and are employed to provide an added measure of protection to sensitive watersheds within the ownership.

Remedial measures: Secondly, remedial measures can also be employed to reduce the potential for adverse effects from land use in sensitive watersheds. These measures might include road upgrading and storm-proofing (surfacing, outsloping, drainage improvement, etc.), road decommissioning (planned closure, either temporary or permanent), erosion control work, landslide stabilization and stream channel improvement projects. Pacific Lumber Company is currently employing a variety of these measures on a site-specific basis, and their use is expanding as heavy equipment is upgraded and personnel are trained.

Site Recovery

Most areas disturbed by land use tend to return towards their natural state over time, depending on the nature and magnitude of the disturbance. Some land use, such as road construction, will continue to have some effect for as long as the feature exists in the watershed.

In reality, recovery is probably a non-linear process in nature, and some elements which influence geomorphic recovery are episodic, like the climatic events that control much of landform development. An example of the non-linear recovery is the change in root shear strength following clear cutting of Douglas-fir forests. Root strength drops off in a non-linear decline for a number of years following harvest, but then picks up again as the root systems from the young second growth forest begin to reestablish.

Similarly, surface erosion of bare soil areas does not diminish in a linear fashion, but probably increases following disturbance and then drops off exponentially as an armor develops and vegetation is reestablished. Different geomorphic settings and processes also recover at different rates. Thus, surface erosion may return close to background within several years, but heavily aggraded stream channels may take decades to flush their stored sediment and recover their natural morphology. Many erosional processes are controlled (driven) by episodic hydrologic events and their recovery is dependent on the magnitude and frequency of storms following the initial disturbance.

The lack of data required to develop accurate curves for various components of watershed recovery, and the complexity of watershed recovery processes, limits the use of non-linear recovery models. Instead, a linear recovery model is often used to estimate the overall duration of watershed impacts from land use. Because revegetation rates are very high in most coastal watersheds of the Company's ownership, we have selected a simple linear recovery model with which to evaluate watershed recover over time. Rapid revegetation and resprouting helps reduce both landslide risk and surface erosion rates, and it masks the subtle non-linear recovery processes than might be more apparent in dryer and higher inland watersheds.

Site recovery is affected by several variables, and can refer to both recovery from past practices and recovery from future land use activities. Natural recovery from ***past*** land use depends on the nature of the land use (e.g., an old road with Humboldt crossings, which wash out slowly, or culverted crossings, which wash out comparatively quickly), the time elapsed since land use, and the frequency and magnitude of storms which have occurred in the watershed since the disturbance. Certain types of storm-triggered erosion and sedimentation problems can occur a decade or more after the time of initial land use disturbance. Recovery from past land use can be dramatically accelerated through a program of problem identification and implementation of erosion prevention work such as that being conducted in our "road armoring" program.

The nature and duration of effective site recovery from ***future*** land use is also dependent on a number of variables, including operator "care," project location, the magnitude and frequency of post-project storm events, revegetation rates, and other factors. For example, vegetative recovery (from a hydrologic perspective) is likely to be much more rapid within the coastal influence area than for areas further inland. Effective hydrologic recovery may take 30 years or more in inland watersheds or in areas dominated by rain-on-snow events, but be much quicker in low elevation coastal watersheds.

Other factors are also likely to be important in determining recovery rates, including the type and location of disturbance. For example, surface erosion can be expected to diminish rapidly in the first few years following disturbance in the wet coastal region. Similarly, ridge-top disturbances (e.g.., ridge roads) are less likely to result in significant impacts to the aquatic system (compared to midslope or lower slope roads) and overall recovery from this type of “distant” disturbance will be relatively rapid.

Conclusions

Developing a simplistic disturbance index for the ownership allows us to evaluate the relative magnitude of present watershed disturbance in context with the existing aquatic conditions of our streams. It is a tool that will help us evaluate our past practices and to take steps and make improvements anywhere conditions might have deteriorated to unacceptable levels. It is also a tool that allows us to predict the outcome of future forest management activities (harvesting and yarding) that are suggested by the sustained yield plan.

Perhaps more importantly, a relative disturbance index for forest practice activities on the property can be used in conjunction with the watershed sensitivity assessment to broadly guide future land management in a fashion that minimizes disturbance to potentially sensitive terrain and thereby reduces the potential for accelerated erosion and sediment yield to streams. It is a planning tool that will be most successful when used in conjunction with the broad array of on-the-ground watershed protection and recovery practices now being implemented.

SYP/HCP Disturbance Index

The primary assumptions underlying the disturbance index (DI) developed for the SYP/HCPare that:

- Different types and combinations of timber management activities and yarding methods produce different levels of sediment; and

- Sediment production from a given activity diminishes over time.

As in the ERA approach, each type of silvicultural activity was assigned a disturbance rating that reflects the intensity and duration of its effects (Table 1). In general, the greater the ground disturbance, the greater the risk of erosion and sediment yield, and the higher the disturbance rating. In this regard, the DI and ERA ratings are very similar. However, the DI is customized to give a higher disturbance rating than the ERA approach to tractor yarding. In addition, instead of treating roads as a separate factor, the DI correlates roads with the yarding methods.

As in the ERA approach, the DI also considers the diminishment of impacts over time, with the DI using a 10-year time factor and ERA using 30 years. It must be emphasized, however, that neither the DI nor the ERA time lines should be construed as being the actual time to recovery. In both approaches, the time factor allows for comparative analysis of cumulative impacts from proposed activities. Further, a 10-year DI time factor was selected for reasons connected to SYP planning and implementation. PALCO has detailed information on silvicultural activities for the past ten years (1986-1996), and that information can be used to calculate a baseline DI for the plan area. The baseline DI in turn can be used as a point of comparison for impacts from activities under the LTSY projection (presented in 10-year intervals).

To calculate the DI for a given area (e.g., PALCO lands within a WAA or the area covered by a THP), the silvicultural practices and yarding methods used in the area over the past 10 years and the number of acres where each treatment occurred are identified. The acres of a treatment are multiplied by the disturbance rating for the silvicultural practice and by the rating for the yarding method. This product is then multiplied by the time factor (10 minus the number of years elapsed since the treatment occurred) and divided by 10. The sum of the results for each treatment is then calculated and divided by the total acres in the area, expressing the DI as a percentage. Table 2 provides a sample calculation for a 500-acre area.

TABLE 1
DI RATINGS FOR TIMBER MANAGEMENT ACTIVITIES

Silviculture Practice	Rating	Yarding Method	Rating
Clearcut	1	Tractor	1
Overstory Removal	0.7	Cable Skyline	0.6
Seed Tree Step	0.7	Tractor and Cable	0.7
Seed Tree Removal	0.7	Salvage	0.7
Shelterwood Preparation Step	0.5	Unknown	0.7
Shelterwood	0.6	Cable Highlead	0.7
Shelterwood Removal	0.7	Helicopter	0.4
Rehabilitation	0.7		
Commercial Thin	0.5		
Selection	0.5		
Transition	0.6		
Alternative	0.5		
Salvage	0.3		

TABLE 2
SAMPLE DI CALCULATION FOR 500-ACRE AREA

Acres	Silviculture Practice (rating)	Yarding Method (rating)	Date of Activity (time factor)	Current Impact Rating
200	clear cut (1)	tractor (1)	1988 (10-9)	20
50	selection harvest (.5)	helicopter (.4)	1993 (10-4)	6
150	overstory removal (.7)	tractor (1)	1995 (10-2)	84
100	not managed since 1985			0
			Total Impact Rating	110
			DI for the 500-acre Area	**22%**